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CONTRIBUTIONS TO THE LIFE-HISTORY OF SYMPLOCARPUS FŒTIDUS.

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It seems that the characteristic property which has given to this plant its popular name and its malodorous reputation has further served to render it immune from the attacks of scientists. Hence, although a prominent feature of our flora, a plant of wide distribution and a member of a group which is especially interesting in its position and relations, yet comparatively little concerning its anatomy or life-history has found its way into the annals of botany. The difficulties attendant upon its study are augmented by its unattractive habitat, and the fact that many of its life processes are carried on under a heavy blanket of snow. When, late in February, openings begin to appear at the summits of cone-shaped, snow-walled cavities (note 1), to announce the advent of this earliest herald of plant life, one finds that he has already flaunted his pollen within the warm, thick-hooded spathe, which nestles close to a sturdy leaf-roll. But the initial stages of growth may be studied through July and August. At this time the next year's spadix is already differentiated deep down in the heart of the plant, usually six inches or more below the surface of the ground. Now, too, one finds close to the perennial rootstock, where they have fallen from the fleshy spadix of the previous autumn, a handful of brown, bulblet-like seeds, from one to one and one-half centimetres in diameter. These seeds are described by Gray in his " Manual " as " filled by the large, globular and fleshy, corm-like embryo which bears one or several plumules at the end next the base of the ovary ; albumen none." In the large number of seeds examined we have failed to find, in any case, more than one plumule. The plumule consists of a central axis, upon which are born several rudimentary leaves, forming successive over-lapping layers. As fast as these cap-like layers push out into true leaves, new layers are cut off from the tip of the axis. The axis contains a ring of well-defined vascular tissue, which extends from the base of the plumule nearly to the opposite end of the seed, and becomes more and more conspicuous as the xylem hardens with the growth of the seedling. The radicle is entirely wanting, and hence no primary root is developed. The plumule and axis are wholly surrounded by the fleshy scutellum, which is so largely developed here as to fill the entire seed. It is composed of loose-celled tissue of a bluish color, richly stored with proteids, which take stain very readily. The axis of the embryo gradually lengthens into rootstock, which contains a central cylinder, limited by the ring of vascular tissue, and interspersed with numerous concentric vascular bundles, irregularly arranged, and much contorted. From these bundles secondary roots develop adventitiously after the plumule has attained considerable size.

The continuation of the bundles from the rootstock to the petioles is not distinctly traceable and, moreover, the bundles of the petioles and of the blades as they expand are collateral and very regular.

A conspicuous feature in all the tissues of this plant is the extraordinary number of sacs containing raphides. These occur in seed, root, petioles, leaves, spathe and spadix, but are most numerous in the fleshy rootstock, particularly in the regions of the bundles. It has been suggested that these crystals may be the cause of the painful irritation produced in the mouth by tasting of the rootstock. The sensation is similar to that produced by the corm of Indian turnip, with which many people are familiar. The irritation is often pronounced mechanical. One may easily fancy that he feels the needle-like crystals penetrating the tongue and lips. When the crystals are dissolved out with H. Cl. the irritating property disappears. Whether, however, the irritation is mechanical, or is due to the presence of some free acid (like the formic acid of the stinging nettle), which is reduced by the H. Cl., has not been determined. Some discussion of the question relative to Arisærma appeared in the Botanical Gazette for January, 1888, and September, 1889.

When the rootstock first pushes out from the seed, it has a diameter of about one-half centimetre, while the old rootstocks attain a size eight to ten times greater. It has been established by DeBary and others that stems and roots of monocotyledons in general show no secondary changes after the primary differentiation of tissue. Increase in girth, which occurs after this, depends upon " an increase in the volume of existing tissue elements, and not upon a cambiogenetic secondary formation." In exception to this general rule, DeBary says: " Cambium and secondary wood and bast appear, as far as at present known, only in the more or less arborescent stems of *Alvineæ* (Alve, Lomatophyllum, Yucca); of *Beàucarnea* and the *Draceneæ* (Dracena, Cordyline, Aletris etc.); in the tubers of *Dioscoreaceæ* (Dioscora, Tamus, Testudinaria); and the roots of *Draceneæ*. Vines adds to these some shrubby *Iridaceæ*, such as Aristea and the stem of Isoetes. To these exceptional monocotyls must now be added our *Symplocarpus fœtidus*. Entirely surrounding the central cylinder, in which the vascular bundles are disposed, is a ring of meristematic tissue. It consists of from two to five layers of tabular cells. The outer layer conforms more or less closely to the structure of the adjacent parenchymatous cortex, while within the irregular radial and tangential divisions of the cells provide for the formation of the much contorted and curiously disposed xylem and pericycle. Vines, in his enumeration of the various types of secondary thickening, gives the two following descriptions:

First—" There is no primary cambium layer, the bundles being all closed; secondary growth in thickness is effected by a ring of meristem quite external to the primary bundles; this occurs in the stems and roots of monocotyledons (arborescent *Liliaceæ*, such as Yucca and Dracena; and some shrubby *Iridaceæ*, such as Aristea). The ring of meristem is usually developed in the pericycle, but in the roots of *Draceneæ* it is formed partly from the pericycle and partly from the cortex. This meristem ring is not termed a cambium ring, because it does not form wood on one side and bast on the other; but it forms, centrifugally, entire, closed, concentric (with external wood) bundles together with intervening fundamental tissue."

Second—" There is no proper cambium layer, but the primary bundles are invested by a pericyclic meristem ring, which gives rise externally to a considerable amount of parenchymatous secondary cortex, and internally to a small amount of vascular tissue; stem of Isoetes."

Neither of the foregoing types conform strictly to the conditions found in Symplocarpus. The structure here agrees with the first type in that it forms centrifugally entire, closed, concentric bundles and intervening fundamental tissue; but differs from this type in that it also forms, centripetally, parenchymatous cortex. It differs from the second type in that it forms, internally, not a small amount, but a large amount, of true vascular tissue; and also, as before stated, a considerable amount of intervening or pericyclic tissue.

The results of our investigations so far may now be tabulated as follows:

1. The embryo displays a peculiar individuality in the absence of a radicle, the marked development of vascular tissue in the axis and the conversion of the scutellum into a fleshy bulb filling the entire seed

2. There is a probability that the raphides have to do with the irritating taste of the plant, and this probability needs confirming or refuting by chemical analysis.

3. The rootstock contains a layer of meristematic tissue separating the cortex from a central cylinder in which the vascular tissue is disposed, and this meristematic layer gives rise, centrifugally, to complete closed bundles and inter-fascicular tissue and, centripetally, to cortex.

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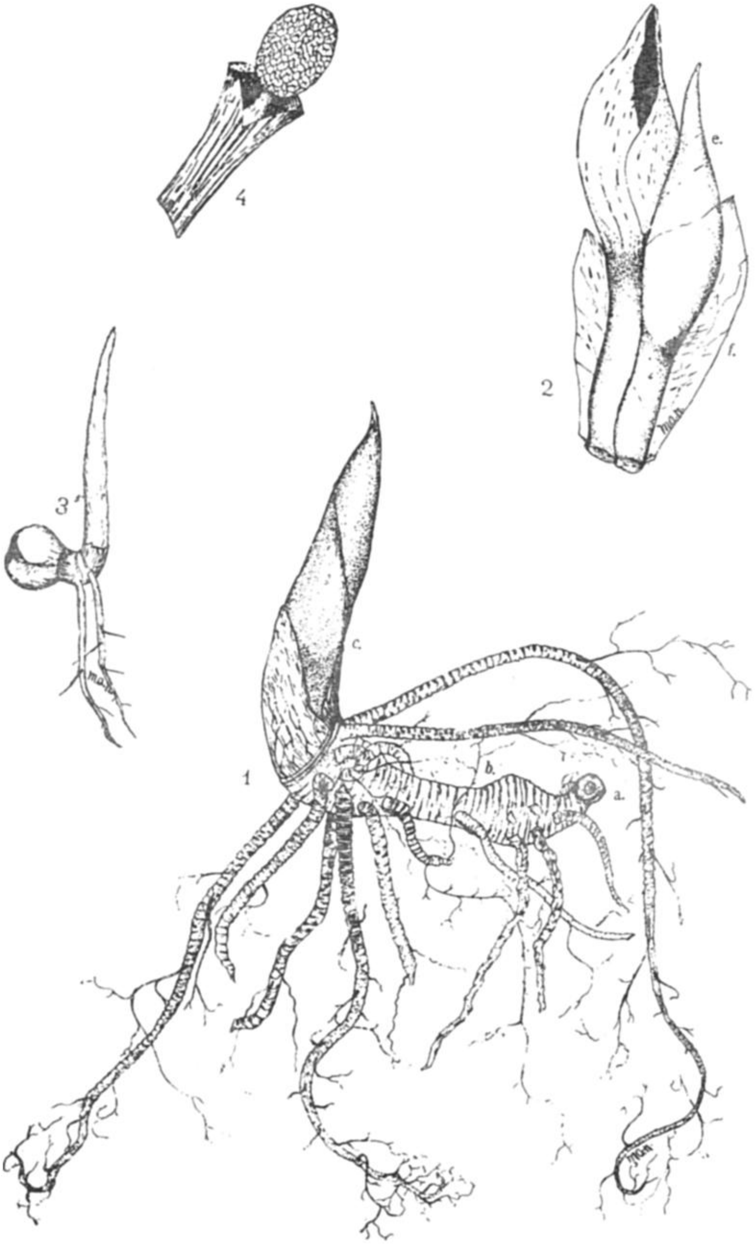
PLATE I.



EXPLANATION OF PLATES.

PLATE I.

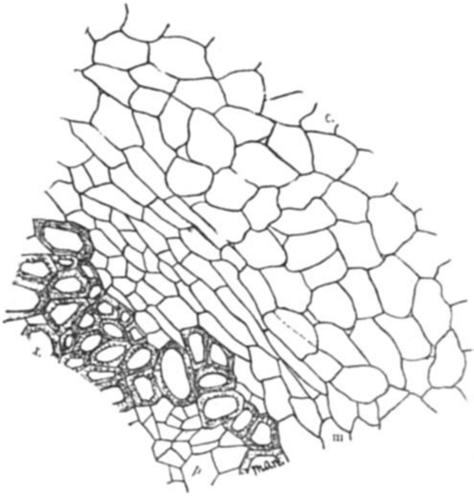
1. Drawn from nature, January 15, 1895. (a) Tip of rootstock. (b) Perennial rootstock. (c) Annual shoot, a leaf-roll only—no flower stalk present.

2. (d) Spathe. (e) Leaf-roll. (f) Enveloping bract.

3. Young seedling, showing seed, leaf-roll and rootlets.

4. Flower cluster, the base of the spathe in longisection and the upper part cut away to show spadix.

PLATE II.



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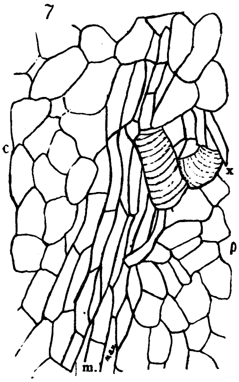

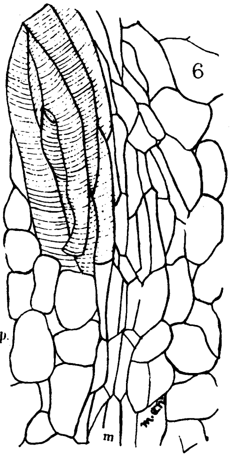

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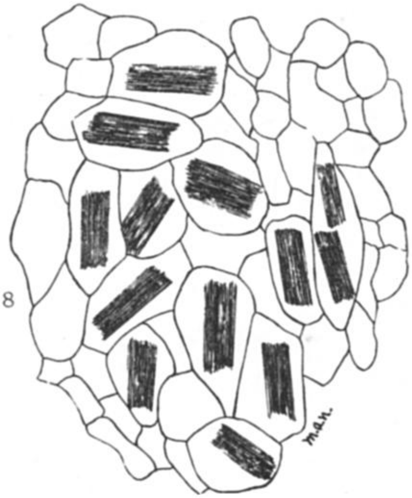

PLATE II.

5. Cross section of rootstock. (c) Cortex. (m) Meristem. (p) Pericycle. (x) Xylem.

6 and 7. Longisections of same.

8. Raphides-bearing cells.

NOTE 1.—These holes in the snow through which the young plants first appeared were so conspicuous and so constant a character as to excite particular attention. They were usually from three to eight inches in diameter, the smaller ones being larger at the base and forming a more or less arching roof over the plant. The unusual regularity of appearance and the fact that the plants were not yet on a level with the surface of the snow, suggested the possibility that the melting of the snow around these plants is induced by heat generated by plant activity. A series of careful experiments was made to determine the difference between the temperature of the plant at the base of the spadix within the spathe and that of the surrounding atmosphere. The maximum difference observed was four degrees C. This was when the temperature of the surrounding atmosphere was 4° C. and the temperature of the plant was 0°.